Tsunami Inundation Maps

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Github repository:
https://github.com/cse512-18s/tsunami-inundation

Context

Coastal cities all along the west coast are susceptible to damage caused by tsunamis. In order to improve tsunami preparedness, researchers turn to numerical simulations to predict the impact of tsunamis caused by different seismological events. One set of simulations, carried out by researchers at the University of Washington, model the effects of several tsunamis on a region of Crescent City, California which has a history of extreme damage from tsunamis. By estimating the probability of occurrence of each simulated tsunami, the annual probability of exceeding a given level of inundation (flooding) can be estimated for every point in the landscape, giving rise to a **hazard map**. There are multiple sources of uncertainty that feed into hazard maps:

1. Estimation of the annual likelihood of different seismic events
2. Error in the numerical simulations of tsunamis resulting from different seismic events
3. Variance due to the relatively small number of simulated events
4. Error due to the assumption that the seismic events are independent

Furthermore, the hazard maps plot complicated hazard functions at every point, which describes the probability of inundation at every depth. Properly interpreting this map can be difficult for people without a technical background.

- Outline methods for generating hazard and inundation maps (or is that too much detail)?

Problem

Our project seeks to address the following problems:

1. Hazard maps and the data used to produce them contain multiple sources of uncertainty. It is challenging to communicate this uncertainty alongside or as part of hazard maps in an intuitive way.
2. Hazard maps are inherently complex and nuanced and can therefore be difficult for non-experts to decipher.

Motivation

An explanation of why the problem is interesting and important.

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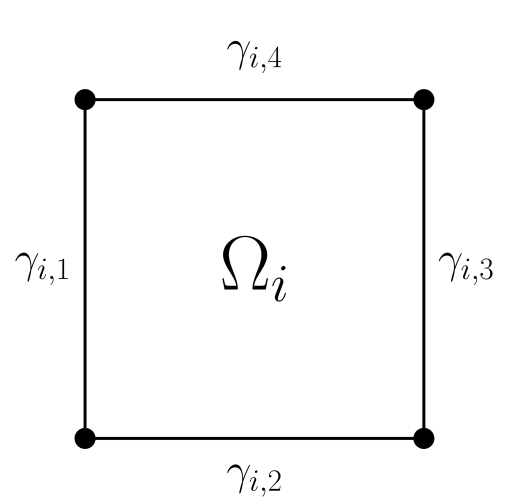

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Approach

Other items we could include:

- Transparency

Moving boundaries

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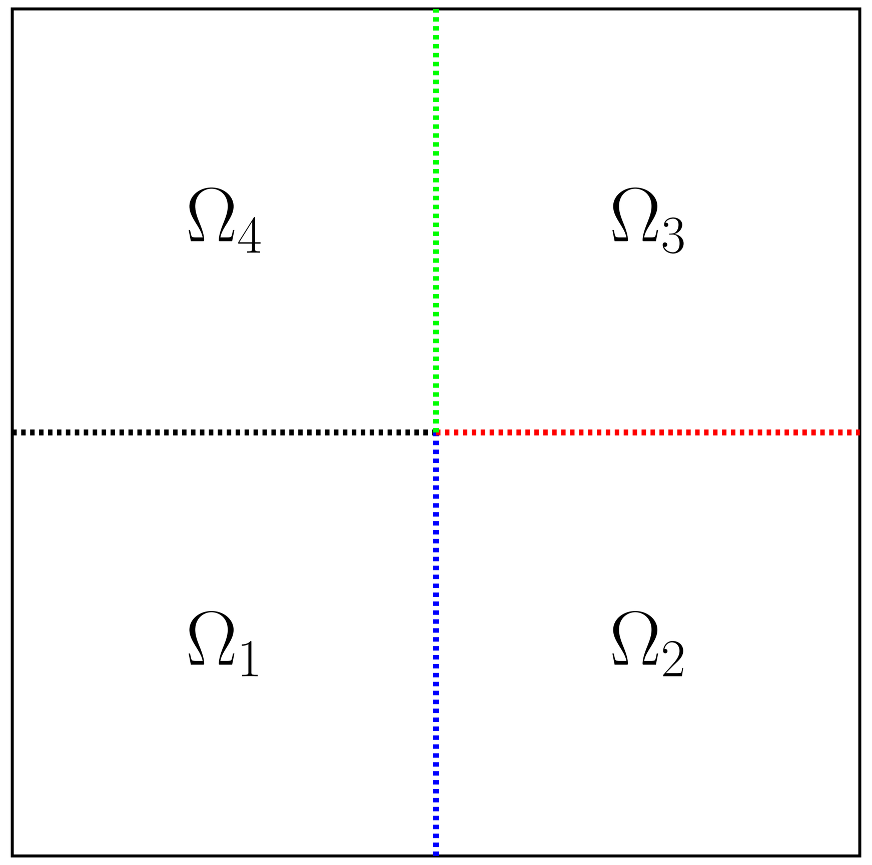
Small multiples



Narrative

To make the visualization more digestible we embed it within a larger narrative structure. In particular, we adopt the “magazine style” approach of [3].

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Results

Screenshots and a working demo, and an indication of how they effectively address your problem.

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h	Offline time (s)	FEM approximation (s)	Our approximation (s)	Modes per port
$1/36$	25	0.12	0.02	25
$1/72$	65	0.43	0.03	28
$1/144$	240	1.86	0.03	31
$1/288$	983	9.26	0.03	32

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Future work?

- thing 1
- thing 2
- thing 3

References

[1] Eduard Bader, Martin A Grepl, and Siegfried Müller. A static condensation reduced basis element approach for the reynolds lubrication equation. *Communications in Computational Physics*, 21(1):126–148, 2017.

[2] Susanne Brenner and Ridgway Scott. *The mathematical theory of finite element methods*, volume 15. Springer Science & Business Media, 2007.

[3] Edward Segel and Jeffrey Heer. Narrative visualization: Telling stories with data. *IEEE transactions on visualization and computer graphics*, 16(6):1139–1148, 2010.

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